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Original Research

Interplay of Regeneration, Structure and Uses of Some Woody Species in Chilimo Forest, Central Ethiopia

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Abstract

Studies on the regeneration, structural and uses of some woody species in Chilimo Forest, one of the dry Afromontane Forests of Ethiopia were conducted. To gather vegetation and environmental data from the study forest, a 900 m^2 (30 m x 30 m) quadrat was laid following the homogeneity of vegetation. Investigation of the seedling density and regeneration of target species has been carried out using the same quadrat size, 30 m x 30 m. In each of these quadrats, the numbers of all seedlings that are up to the height of 150 cm were recorded. Individuals attaining 150 cm and above in height but less than 10 cm thick were considered as sapling and counted. Interview was conducted for the investigation of the various pressures exerted on different species. All together the plant species recorded from Chilimo Forest are 213 which can be categorised into 83 families. Of these, the highest proportion is the angiosperm (represented by 193 species) followed by pteridophyta (16 species); the least represented being the gymnosperms (represented by 2 exotic and 2 indigenous species). Structural and regeneration studies of some woody species indicated that there are species that require urgent conservation measures. To provide a better management and monitoring as well as to maintain the biodiversity, cultural and economic values of the forest unsustainable utility of the forest would be controlled with the various conservation activities in place.

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INTRODUCTION

Chilimo Forest is one of the Dry Afromontae Forests of Ethiopia. Tsegaye Tadesse (expert served in the forest for 20 years, personal com.) stated that the Chilimo Forest was controlled by the close allies of Minilik after his invasion of the area. One of the close allies of Minilik, a French citizen (Komdor) who provided him with war weapons, was the first to get the forest as a favour. After the departure of Komdor, the forest was passed to Ras Mekonnen who in turn passed it to Hailesillassie. It is believed that Hailesillassie built the building in the forest and upon the birth of Leul Mekonnen he transferred the forest to his wife, Itege Menen. Before the Italian invasion, Itege Menen contracted the forest with five foreign investors and the forest began to produce large scale timbers. After the Italian invasion (i.e., between 1937-1968) the forest had been owned by different foreign investors who used sawmills for the production of numerous timber products. These foreign investors include Jana (between 1937-1941), Kazantay (1942-1945), Mozvold (1946-1951), Fogstan (1952-1953) and Vaskin (1954-1968) (Tsegaye Tadesse, personal comm.). After 1968, all the sawmills were forced to stop operation and protection of this forest came into existence. Albeit the declaration of protecting the forest, not enough had been done to circumvent 60% loss of this forest in ten years time.

It is not uncommon to mention that Ethiopia had experienced substantial deforestation, soil degradation and an increase in the area of bare land over the years (Logan, 1946). The need for fuel wood, arable land and grazing areas are the main causes of forest degradation, frequently leading to loss of forest cover and biodiversity, erosion, desertification and reduced water resources. Several studies focussing on forests or vegetation of specific regions in Ethiopia (Hedberg, 1951 and 1957; Mooney, 1963; Gilbert, 1970; Coetzee, 1978; Friis *et al.*, 1982; Hailu Sharew, 1982; Zerihun Woldu, 1985; Sebsebe Demissew, 1988; Uhlig, 1988; Zerihun Woldu et al., 1989; Uhlig and Uhlig, 1990; Zerihun Woldu and Backeus, 1991; Haugen, 1992; Mesfin Tadesse, 1992; Tamrat Bekele, 1994; Miehe and Miehe, 1994; Demel Teketay, 2000 and Teshome Soromessa *et. al.,* 2004; Ensermu Kelbessa and Teshome Soromessa, 2008; Teshome Soromessa and Ensermu Kelbessa 2013a and 2013b) have been carried out. Moreover, the vegetation resources of Ethiopia, including forests, woodlands and bush lands, have been studied by several scholars (Russ, 1945 compiled by Woldemichael Kelecha, 1979; Logan,

1946; Pichi-Sermolli, 1957; von Breitenbach, 1961, 1963; Westphal, 1975; Chaffey, 1979; Tewolde Berhan Gebreziabher, 1986, 1988, 1991; Friis, 1986, 1992; Friis and Mesfin Tadesse, 1990; EFAP, 1994) who have employed different methods of vegetation classification. Specific studies pertaining to carbon sequestration potentials of Afromonatne forests and genera related ones have been carried out (Teshome Soromessa, 2013; Adugna Feyissa *et al,* 2013). Almost all the aforementioned studies have made a pencil note about the intractable loss of this natural resource.

MATERIALS AND METHODS

The Study Area

The Chilimo Forest (collectively known as Chilimo Gaji Forest) is situated 97 km west of Addis Ababa, 7 km north of the small town of Ginchi and close to the main road running to Ambo (Fig.1). Altitudinally, the forest area ranges between 2170 to 3054 m a.s.l. The forest is a small enclave in the western section of the ridge that stretches from the capital westward to Gedo highlands and covers some ca. 2500 ha though the area allocated as forest is more. The inhabitants of the area are the Oromos with some other ethnic groups settled in the heart of the forest, who came to the area to work as a daily labourers at the time of the operation of the sawmill. According to Tamrat Bekele (1994) and Friis (1992), the Chilimo Gaji Forest belongs to Dry Afromontane forest type. In Ginchi and the surrounding Chilimo area, there are five rainy months extending from May-Sept with the highest peak in July. Ginchi belongs to Type I rainfall regime of Daniel Gamachu's (1977) class.

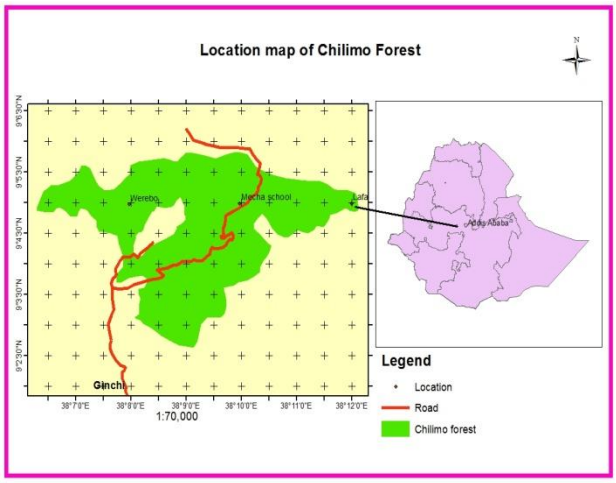


Figure 1: Location map of the study area.

Geology and Soils

According to Mohr (1971), the geology of Ethiopia was grouped into: a) the Precambrian basement complex of various grades and types of schists, gniessis etc., and to a lesser extent unaltered sedimentary rocks and igneous intrusions, b) the Mesozoic mantle sediments that were deposited during a transgression in the Upper Jurassic when the sea engulfed the country from the south-east and c) the cover deposits.

In the central Plateau including Chilimo, basalt constitutes the main rock types that are chemically and mineralogically uniform in composition. It is however, important to note that in most parts of the country, the basement rocks are overlain by more recent rocks (flood lavas) of the Tertiary period occurring in series and finally formed what is known as the Trap Series. The volcanic rocks of these series include rhyolites, trachytes, tuffs, ignimbrites, agglomerates and basalt forming the substrate of most types of Afromontane forest (Mohr, 1971). With regard to the soil, a generalised account on the Nature and Management of Ethiopian Soils was in Mesfin Abebe (1998), with particular references to their genesis, classification, distribution and sound management aimed at their sustainable utilisation. Others like Logan (1946), Murphy (1958), Westphal (1975), EMA (1988) also made descriptions and surveys of Ethiopian soils. Based on the aforementioned works, it can be said that the major soil types around Chilimo areas are various types of Vertisols, Luvisols and Cambisols dominates in the areas.

Vegetation

The works of White (1983) and Friis (1992) had eloquently described the forest of Ethiopia with the characteristic species. Consequently, the Chilimo Forest could be categorised in Undifferentiated Afromonate Forest type of Friis (1992), where the forests are either *Juniperus-Podocarpus* Forests, or predominantly *Podocarpus* Forests, both with and element of broad-leaved species.

Sampling Design

A reconnaissance survey of the study forest was made so as to obtain an impression and visual description of the general vegetation physiognomy and hypothesise vegetation-environment relationships such as altitude, slope and aspect. Discussion pertinent to forest resources was conducted with the local people (particularly the beneficiaries of the forest) in the study area.

Vegetation and Environmental Data

Data on vegetation and environmental parameters were gathered using a 900 m^2 (30 m x 30 m) quadrat which was laid following the homogeneity of vegetation. Sample plots were selected through preferential means in such a way that the various conditions encountered represented in the study forest. Woody species were counted. Additional tree and shrub species within 10-m distance from the plot boundaries were recorded as present. Diameter at Breast Height (DBH) and height of all woody species that are above 150 cm high and more than 10 cm thick were recorded. DBH was measured using a meter tape and height of individuals was measured using Clinometer.

Investigation of the seedling density and regeneration of target species has been carried out using the same quadrat size, 30 m x 30 m. Partitions were made within the big quadrat so as to make seedling counts easier. In each of these quadrats, the number of all seedlings that are up to the height of 150 cm was recorded. Individuals attaining 150 cm and above in height but less than 10 cm thick were considered as sapling and counted.

Interview was conducted for the investigation of the various pressures exerted on different species. The local people, who are more likely to know plant vernacular names and their detailed uses, were interviewed. The information on vernacular names and the various uses of species were gathered from the informants via repeated field interviews as described in Maundu (1995); Kamatenesi-Mugisha *et al.* (2000) and Kakudidi *et al.*

(2002). Plant specimens were identified at the National Herbarium and in the field. All voucher specimens that were in flowering and/or fruiting stages were brought to the National Herbarium of Addis Ababa University and deposited. Nomenclature of plant taxa follows the published volumes of Flora of Ethiopia and Eritrea.

Data Analysis

The vegetation and environmental data gathered from the field were fed into a computer for the subsequent analysis of the data. The vertical structure of the forests were described following the International Union for Forestry Research Organisation (IUFRO) classification scheme (Lamprecht, 1989) that categorise the vertical structure as upper, middle and lower storeys. The population structures of some selected species were analysed for the interpretation of the pattern of population dynamics in the forest.

RESULTS AND DISCUSSIONS

Diversity of Chilimo Forest

Analysis of the gathered data indicated that there exists a diverse plant species occurring in the forest investigated for the present study. The gathered plant species include pteridophyta, gymnosperms and angiosperms. All together the plant species recorded from Chilimo Forest are 213 and can be categorised into 83 families. As shown in Figure 2, the highest proportion is the angiosperm (represented by 193 species) followed by pteridophyta (16 species); the least represented being the gymnosperms (represented by 2 exotic and 2 indigenous species).

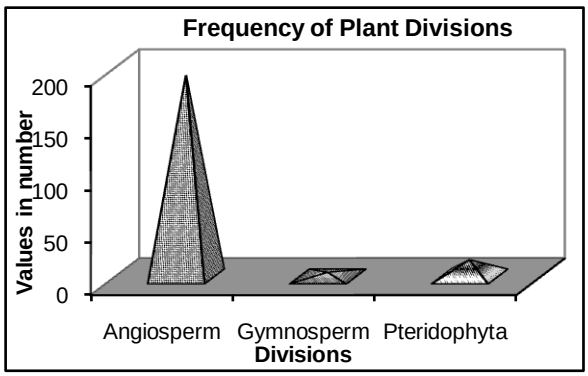


Figure 2: Proportions of angiosperm, gymnosperms and pteridophytes in Chilimo Forest.

Complete lists of the species recorded from Chilimo Forest with their family and local names are provided as Appendix 1. Based on the information presented in Appendix 1, it can be seen that the highest proportion of the habit or form is the herbaceous component. From the same list, however, the dominant family in the forest is Asteraceae that is represented by 28 species making a total proportion of 13% of the total species in the list.

Floristics

The Chilimo Forest is one of the Afromontane Forests in the country. Despite its proximity to the center, this forest has been studied repeatedly, *inter alia*, Tamrat Bekele (1994) made a significant contribution. Floristically, Juniper and Podo are the emergent species in the forest. Other important species include *Scolopia theifolia, Olea europaea, Maytenus gracilipes, Myrsine africana, Allophylus abyssinicus, Erica arborea, Bersama abyssinica, Olinia rochetiana, Nuxia congesta, Prunus africana, Sideroxylon oxyacanthum, Osyris quadripartita, Plantago palmata, Satureja paradoxa, S. nilotica, Carissa edulis, Hypoestes forsskaolii* and *Geranium arabicum.*

Vertical Structure

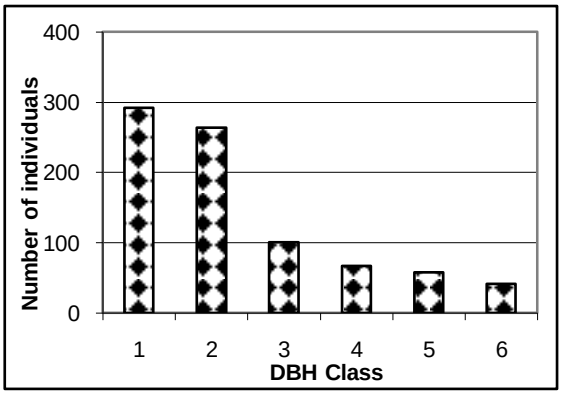
The vertical structure of the woody species occurring in the Chilimo Forest was analysed using the IUFRO classification scheme as cited in (Lamprecht, 1989). The scheme classifies the storey into upper, where the tree height is greater than 2/3 of the top height; middle, where the tree height is in between 1/3 and 2/3 of the top height and the lower storey where the tree height is less than 1/3 of the top height. The top height here is considered as 45 m. Accordingly, in Chilimo Forest, the upper storey of the forest is either *Juniperus* or *Podocarpus* or predominated by both emergent species. In most of these forests, the middle storey is dominated by species like *Olea europaea, O. capensis, Scolopia theifolia* and *Allophylus abyssinicus*. The lower storey of the forests is largely composed of small trees and shrubs such as *Myrsine africana, Teclea nobilis* and *Bersama abyssinica.*

Density

Density of a given species is expressed as number of stems per hectare. In Chilimo Forest, the highest density was recorded for *Maytenus gracilipes* (258.7 individuals per hectare), which is followed by *Podocarpus falcatus* (120 individuals per hectare) and *Scolopia theifolia* (109.3 individuals per hectare), while the least density of species was recorded for *Gnidia glauca* that contributed less than an individual per hectare.

DBH and Height Profile

The DBH and Height classes data of the Chilimo Forest are presented in Figures 3 and 4 below. The DBH classes showed continuous decrease in number of individuals with increase in class sizes. Those belonging to DBH classes 1-3 contributed about 79.8% of the number of individuals. This shows that small sized individuals dominate the forest.



Legend: 1=10-20 cm, 2=20.1-50 cm, 3=50.1-80 cm, 4=80.1-110 cm, 5=110.1-140 cm, 6= > 140 cm.

Figure 3: DBH classes versus number of individuals in Chilimo Forest.

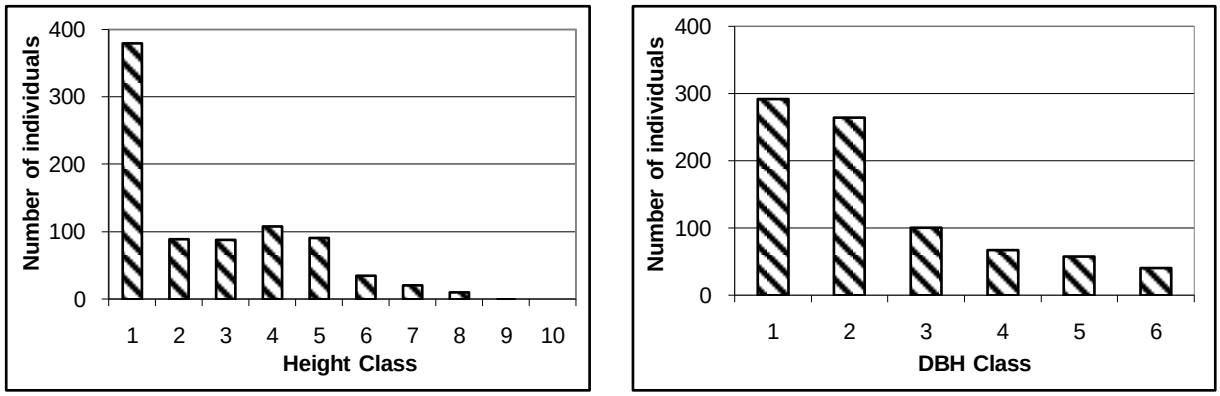
The height of individuals in Chilimo Forest showed a trend where the shorter individuals predominate in the forest. As seen from Figure 4, of trees and shrubs investigated for height in Chilimo Forest, individuals belonging to Height classes 1-5 contribute about 91.7%, while the remaining 8.3 % are those above 18 meters. A slight increase in the number of individuals in the classes 4 and 5 has been contributed by the slight increment of *Juniperus procera, Olea europaea* and *Allophylus abyssinicus* species in these classes.

Table 1: Alphabetical list of species recorded from Chilimo Forest.

Scientific name	Afaan Oromoo	Family	Habit
Acacia abyssinica Hochst. ex Benth.	Laaftoo Adii	Fabaceae	Tree
Acacia lahai Steud. and Hochst. ex Benth.	Laaftoo Gurraacha	Fabaceae	Tree/shrub
Acanthus sennii Chiov.	Kosorruu	Acanthaceae	Shrub
Achyranthes aspera L.		Amaranthaceae	Herb
Acmella caulirhiza Del.		Asteraceae	Herb
Adiantum thalictroides Willd. ex Schlecht.		Adiantaceae	Fern
Agrocharis melanantha Hochst.	Qurfoo	Apiaceae	Herb
Alchemilla abyssinica Fresen.		Rosaceae	Herb
Allophylus abyssinicus (Hochst.) Radlk.	Sarara	Sapindaceae	Tree
Anthospermum herbaceum L.f.		Rubiaceae	Herb
Apodytes dimidiata E. Mey. ex Arn.	Calalaqa	Icacinaceae	Tree
Arisaema enneaphyllum Hochst. ex A.Rich.		Areceae	Herb
Arundinaria alpina K. Schum.	Shimala	Poaceae	Bamboo
Asparagus africanus Lam.	Sariitii	Asparagaceae	Shrub
Asplenium abyssinicum Fée		Aspleniaceae	Fern
Asplenium aethiopicum (Burm.f.) Bech.		Aspleniaceae	Fern
Asplenium monanthes L.		Aspleniaceae	Fern
Asplenium protensum Schrad.		Aspleniaceae	Fern
Asplenium theciferum (Kunth) Mett.		Aspleniaceae	Fern
Bersama abyssinica Fresen.	Lolchiisaa	Melianthaceae	Shrub/tree
Buddleja polystachya Fresen.		Loganiaceae	Shrub/tree
Calpurnia aurea (Ait.) Benth.	Ceekaa	Fabaceae	Shrub/tree
Carduus leptacanthus R.E. Fries		Asteraceae	Herb
Carduus schimperi Sch. Bip. ex A. Rich	Kosorruu	Asteraceae	Herb
Carex confertus A.Rich.		Cyperaceae	Herb
Carissa spinarum L.	Agamsa	Apocynaceae	Climber
Cassipourea malossana (Baker) Alston	Gaachan Fullaas	Rhizophoraceae	Tree
Centella asiatica (L.) Urban		Apiaceae	Herb
Cheilanthes farinosa (Forssk.) Kaulf.		Sinopteridaceae	Fern
Chenopodium ambrosioides L.		Chenopodiaceae	Herb
Clausena anisata (Willd.) Benth.	Ulmaa	Rutaceae	Shrub/tree
Clematis simensis Fresen.	Fiitii	Ranunculaceae	Climber
Clerodendrum myricoides Vatke		Lamiaceae	Shrub
Clutia abyssinica Jaub. and Spach.		Euphorbiaceae	Herb
Commelina africana L.		Commelinaceae	Herb
Conyza bonariensis (L.) Cronq.		Asteraceae	Herb
Conyza hochstetteri Sch.Bip. ex A.Rich.		Asteraceae	Herb
Conyza hypoleuca A.Rich.		Asteraceae	Shrub
Conyza nana Sch.Bip. ex Oliv. and Hiern		Asteraceae	Herb
Conyza pedunculata (Oliv.) Willd.		Asteraceae	Herb
Conyza schimperi Sch.Bip. ex A. Rich.		Asteraceae	Herb
Conyza stricta Willd.		Asteraceae	Herb
Crassula alsinoides (Hook.f.) Engl.		Crassulaceae	Herb
Craterostigma pumilum Hochst.		Scrophulariaceae	Herb
Crotalaria incana L.	Kilkilloo	Fabaceae	Herb
Crotalaria quartiniana A.Rich.		Fabaceae	Herb
Crotalaria rosenii (Pax) Milne-Redh. ex Polhill		Fabaceae	Herb/shrub
Croton macrostachyus Del.	Makkanniisa	Euphorbiaceae	Tree
Cupressus lusitanica Miller		Cupressaceae	Tree
Cycnium humifusa (Forssk.) Engl.		Scrophulariaceae	Herb
Cynodon dactylon (L.) Pers.		Poaceae	Grass
Cynoglossum amplifolium Hochst. ex A.Rich.		Boraginaceae	Herb
Cynoglossum geometricum Bak. and Wright	Maxxaannee	Boraginaceae	Herb
Cyperus bulbosus Vahl		Cyperaceae	Herb
Cyperus niveus Retz.		Cyperaceae	Herb
Cyphostemma cyphopetalum (Fresen.) Decne ex Wild and Drummond		Vitaceae	Climber
Desmodium repandum (Vahl) DC.		Fabaceae	Herb
Dichondra repens J.R. and G. Forest.		Convolvulaceae	Herb
Dichrocephala integrifolia (L.f.) Kuntze		Asteraceae	Herb
Discopodium penninervum Hochst.	Coocingaa	Solanaceae	Shrub
Dombeya torrida (G.F.Gmel.) P. Bamps	Daannisaa	Sterculiaceae	Tree
Dovyalis abyssinica (A.Rich.) Warp.	Koshommii	Flacourtiaceae	Shrub
Dregea schimperi (Decne) Bullock		Asclepiadaceae	Climber
Dregea schimperi (Decne) Bullock		Asclepiadaceae	Climber
Drynaria volkensii Hieron		Polypodiaceae	Fern
Dryopteris inaequalis (Schlecht.) Kuntze		Aspidiaceae	Fern
Dyschoriste multicaulis (A.Rich.) O. Kuntze		Acanthaceae	Herb
Echinops macrochaetus Fresen.	Kosorruu Harree	Asteraceae	Herb
Ekebergia capensis Sparrm.	Somboo	Meliaceae	Tree
Embelia schimperi Vatke	Aanquu	Myrsinaceae	Climber/(tree)
Epilobium hirsutum L.		Onagraceae	Herb

Scientific name	Afaan Oromoo	Family	Habit
Eragrostis schweinfurthii Chiov.		Poaceae	Grass
Erica arborea L.	Maxaaxee	Ericaceae	Tree/shrub
Eucalyptus globulus Labill.		Myrtaceae	Tree
Euphorbia platyphllos L.	Ichima	Euphorbiaceae	Herb
Ficus sur Forssk.	Harbuu	Moraceae	Tree
Galiniera saxifraga (Hochst.) Bridson	Buniitii	Rubiaceae	Tree/shrub
Galinsoga parviflora Cav.		Asteraceae	Herb
Galium spurium L.	Saam'ee	Rubiaceae	Herb
Geranium arabicum Forssk.		Geraniaceae	Herb
Girardinia bullosa (Steudel) Wedd.	Doobbii	Urticaceae	Herb
Gnidia glauca (Fresen.) Gilg.	Diddiksaa	Thymelaeaceae	Shrub/tree
Hagenia abyssinica (Bruce) G.F. Gmel.	Heexoo	Rosaceae	Tree
Haplocarpha schimperi (Sch.Bip.) Beauv.		Asteraceae	Herb
Harpachne schimperi Hochst. ex A.Rich.		Poaceae	Grass
Helichrysum forskaolii (G.F.Gmel.) Hilliard and Burtt		Asteraceae	Herb
Heracleum abyssinicum (Boiss.) Norman		Apiaceae	Herb
Hypericum peplidifolium A.Rich.		Clusiaceae	Herb
Hypericum quartinianum A.Rich.	Hindhee	Clusiaceae	Shrub/tree
Hypericum revolutum Vahl		Clusiaceae	Shrub/tree
Hypoestes forskaolii (Vahl) R.Br.		Acanthaceae	Herb
Hypoestes triflora (Forssk.) Roem. and Schult.		Acanthaceae	Herb
Hypoxis villosa L.f.		Hypoxidaceae	Herb
Ilex mitis (L.) Radlk.	Mi'eessaa	Aquifoliaceae	Tree
Impatiens hochstetteri Warp.		Balsaminaceae	Herb
Impatiens rothii Hook.f.		Balsaminaceae	Herb
Indigofera arrecta Hochst. ex A.Rich.		Fabaceae	Shrub
Isoglossa somalensis Lindau		Acanthaceae	Herb
Jasminum abyssinicum Hochst. ex A.Rich.	Michilbee	Oleaceae	Climber
Juniperus procera L.	Gaattiraa	Cupressaceae	Tree
Justicia schimperiana (Hochst. ex Nees) T. Anders.	Dhummuugaa	Acanthaceae	Shrub
Kalanchoe densiflora Rolfe	Bosoqqee	Crassulaceae	Herb
Kalanchoe petitiana A.Rich.	Bosoqqee	Crassulaceae	Herb
Lagenaria siceraria (Molina) Standl.	Buqqee Seexanaa	Cucurbitaceae	Climber
Laggera crispata (Vahl) Hepper and Wood		Asteraceae	Herb
Leucas argentea Gurke		Lamiaceae	Herb
Leucas punctata (Benth.) Briq.		Lamiaceae	Herb
Lippia adoensis Hochst. Ex Walp.	Kasee	Verbenaceae	Shrub
Lobelia giberroa Hemsl.	Faaggaa	Lobeliaceae	Herb
Loxogramme lanceolata (Swartz) Presl.		Polypodiaceae	Fern
Maesa lanceolata Forssk.	Abbayyii	Myrsinaceae	Tree/shrub
Maytenus addat (Loes.) Sebsebe		Celastraceae	Tree/shrub
Maytenus arbutifolia (A.Rich.) Wilczek		Celastraceae	Shrub/tree
Maytenus gracilipes (Welw. ex Oliv.) Exell	Qarxammee	Celastraceae	Shrub/tree
Mikaniopsis clematoides (A.Rich.) Milne-Redh.		Asteraceae	Climber
Mimulopsis solmsii Schweinf.		Acanthaceae	Herb
Myrica salicifolia Hochst. ex A.Rich.	Barooddoo	Myricaceae	Tree
Myrsine africana L.	Qacama	Myrsinaceae	Shrub/tree
Myrsine melanophloeos (L.) R.Br.		Myrsinaceae	Tree/(shrub)
Nuxia congesta R.Br. ex Fresen.	Qawwisa	Loganiaceae	Tree/shrub
Oenanthe palustris (Chiov.) Norman	Goojjiyyee	Apiaceae	Herb
Oldenlania monanthos (A.Rich.) Hiern		Rubiaceae	Herb
Olea capensis L. subsp. *macrocarpa* (C.A.Wright) Verdc.	Gagamaa	Oleaceae	Tree
Olea europea L. subsp. *cuspidata* (Wall. ex G.Don) Cif.	Ejersa	Oleaceae	Tree
Olea welwitschii (Knobl.) Gilg and Schellenb.		Oleaceae	Tree
Olinia rochetiana A.Juss.	Daalachoo	Oliniacae	Shrub/tree
Oplismenus hirtellus (L.) P. Beauv.	Qacaa	Poaceae	Grass
Orobanche minor Smith		Orobanchaceae	Herb
Osyris quadripartita Decne	Waatoo	Santalaceae	Shrub/tree
Oxalis corniculata L.		Oxalidaceae	Herb
Oxalis procumbens Steud.ex A.Rich.		Oxalidaceae	Herb
Pavetta abyssinica Fresen.		Rubiaceae	Shrub
Pavonia urens Cav.		Malvaceae	Shrub
Pellaea quadripinnata (Forssk.) Prantl.		Adiantaceae	Fern
Pennisetum clandestinum Chiov.	Saardoo	Poaceae	Grass
Pennisetum sphacelatum (Nees) Th.Dur. and Schinz	Migira	Poaceae	Grass
Pentas schimperiana (A.Rich.) Vatke		Rubiaceae	Shrub/herb
Peperomia abyssinica Miq.		Piperaceae	Herb (epiphyte)
Periploca linearifolia Quart.-Dillon and A.Rich.	Aannannoo	Asclepiadaceae	Climber
Persicaria nepalensis (Meisn) Miyabe		Polygonaceae	Herb
Persicaria setosula (A.Rich.) K.L. Wilson		Polygonaceae	Herb
Peucedanum mattirolii Chiov.		Apiaceae	Herb
Peucedanum petitianum A.Rich.		Apiaceae	Herb
Phragmenthera macrosolen (A.Rich.) M. Gilbert		Loranthaceae	Semi-parasite
Phytolacca dodecandra L'Herit.	Andoodee	Phytolaccaceae	Shrub

Scientific name	Afaan Oromoo	Family	Habit
Pinus patula Schlecht. and Chamiso		Pinaceae	Tree
Pittosporum viridiflorum Sims		Pittosporaceae	Tree/shrub
Plantago lanceolata L.	Qorxobbii	Plantaginaceae	Herb
Plantago palmata Hook.f		Plantaginaceae	Herb
Plectranthus garckeanus Vatke		Lamiaceae	Herb
Plectranthus punctathus L'Herit		Lamiaceae	Herb
Pleopeltis macrocarpa (Willd.) Kaulf.		Polypodiaceae	Fern
Pleopeltis phlemodes (Mett.) Pici-Serm.		Polypodiaceae	Fern
Podocarpus falcatus (Thunb.) Mirb.	Birbirsa	Podocarpaceae	Tree
Polygala sphenoptera Fresen		Polygalaceae	Herb
Polystachya rivae Schweinf.		Orchidaceae	Herb
Prunus africana (Hook.f.) Kalkm.	Hoomii/Gurraa	Rosaceae	Tree
Pseudognaphalium luteo-album (L.) Hilliard and Burtt		Asteraceae	Herb
Pseudognaphalium richardianum (Cuf.) Hilliard and Burtt		Asteraceae	Herb
Pteris cretica L.		Adiantaceae	Fern
Pteris dentata Forssk.		Adiantaceae	Fern
Pterolobium stellatum (Forssk.) Brenan		Fabaceae	Climber
Ranunculus multifidus Forssk.		Ranunculaceae	Herb
Rhamnus staddo A.Rich.	Qadiidaa	Rhamnaceae	Shrub/tree
Rhus glutinosa A.Rich. subsp. *neoglutinosa* (M.Gilbert) M.Gilbert	Xaaxessaa	Anacardiaceae	Shrub/tree
Rhus glutinosa A.Rich.subsp. *glutinosa*		Anacardiaceae	Shrub/tree
Rhus vulgaris Meikle	Daboobessa	Anacardiaceae	Shrub/tree
Rorippa nasturtium-aquaticum (L.) Hayek		Brassicaceae	Herb
Rosa abyssinica Lindley	Inqooxoo	Rosaceae	Shrub/climber
Rubus steudneri Schweinf.	Goraa	Rosaceae	Shrub
Rumex abyssinicus Jacq.		Polygonaceae	Herb
Rumex nepalensis Spreng.	Tuultii	Polygonaceae	Herb
Rumex nervosus Vahl		Polygonaceae	Shrub
Salix mucronata Thunb.	Alaltuu	Salicaceae	Tree
Salvia nilotica Juss. ex Jacq.	Qoricha Michii	Lamiaceae	Herb
Sanicula elata Buch.-Ham. ex D. Don		Apiaceae	Herb
Satureja abyssinica (Benth.) Briq.		Lamiaceae	Herb
Satureja biflora (Ham. ex Don) Briq.		Lamiaceae	Herb
Satureja paradoxa (Vatke) Engl.	Baadu Furdis	Lamiaceae	Herb
Scadoxus multiflorus (Martyn) Raf.	Ija Dhukkubsituu	Amaryllidaceae	Herb
Schefflera abyssinica (Hochst. ex A.Rich.) Harms	Arfattuu	Araliaceae	Tree
Schefflera volkensii (Engl.) Harms		Araliaceae	Tree
Schoenoxiphium sparteum (Whal.) Kuk		Cyperaceae	Herb
Schrebera alata (Hochst.) Welw.		Oleaceae	Tree/shrub
Scolopia theifolia Gilg	Gaallee	Flacourtiaceae	Tree
Selaginella abyssinica Spreng.		Selaginellaceae	Fern
Sida schimperiana A.Rich.		Malvaceae	Herb
Sideroxylon oxyacanthum Baill.	Biitee	Sapotaceae	Shrub/tree
Smilax aspera L.	Harangamaa	Smilacaceae	Climber
Solanecio gigas (Vatke) C.Jeffrey	Bosoqa	Asteraceae	Shrub/tree
Solanecio mannii (Hook.f.) C. Jeffrey		Asteraceae	Shrub/tree
Solanecio tuberosus (Sch.Bip.) C. Jeffrey		Asteraceae	Herb
Solanum anguivi Lam.		Solanaceae	Herb
Solanum incanum L.		Solanaceae	Shrub
Solanum marginatum L.f.	Iddii Baddaa	Solanaceae	Shrub
Solanum nigrum L.		Solanaceae	Herb
Sphaeranthus sauveolens (Forssk.) DC.		Asteraceae	Herb
Stellaria sennii Chiov.		Caryophyllaceae	Herb
Stephania abyssinica Dillin and A.Rich.) Warp.	Kalaalaa	Menispermaceae	Climber
Tagetes minuta L.		Asteraceae	Herb
Teclea nobilis Del.	Hadheessa	Rutaceae	Tree/shrub
Thalictrum rhynchocarpum Dill. and A.Rich.		Ranunculaceae	Herb
Thymus schimperi Ronn.	Xoosanyii	Lamiaceae	Herb
Torilis arevensis (Hudson) Link		Apiaceae	Herb
Trifolium semiplosum Fresen.		Fabaceae	Herb
Uebelinia abyssinica Hochst.		Caryophyllaceae	Herb
Urera hypselodendron (A.Rich.) Wedd.	Laanqisaa	Urticaceae	Climber
Urtica simensis Steudel	Saammaa	Urticaceae	Herb
Vernonia amygdalina Del.	Heebicha	Asteraceae	Tree
Vernonia leopoldi (Sch.Bip.) Vatke	Reejjii	Asteraceae	Shrub
Vernonia rueppellii Sch.Bip. ex Walp.		Asteraceae	Shrub
Vernonia urticifolia A. Rich.		Asteraceae	Herb
Veronica abyssinica Fresen.		Scrophulariaceae	Herb



Legend: 1=1.5-6 m, 2=6.1-9 m, 3=9.1-12 m, 4=12.1-15 m, 5=15.1-18 m, 6=18.1-21 m, 7=21.1-24 m, 8=24.1-27 m, 9=27.1-30 m, 10=> 30m

Figure 4: Height classes versus number of individuals in Chilimo Forest.

In general, the differences observed in DBH and Height classes' distribution could be attributed to the exploitation histories of the forest. These data suggest that the forest was not free from exploitation. However, the extent of exploitation varies from one-forest patches to another. Particularly, the presence of sawmill in this forest for longer period had reduced it to small patches of secondary forest vegetation. Intensive and selective cutting of timber species was believed to be intensified during the Italian occupation where the Forest was in the hand of foreign investors.

Population Structure of Some Species

Thirty-seven woody species were investigated for population structure in Chilimo Forest. The structural analysis showed four major patterns as reproduced in Figs.5 a-h. *Allophylus abyssinicus* and *Prunus africana* form the first pattern (Fig. 5a), which have even distribution of species in the different classes. The second pattern (Fig. 5b) is the pattern formed by *Scolopia theifolia* and *Maytenus gracilipes*. In this pattern more individuals are in the lowest DBH classes.

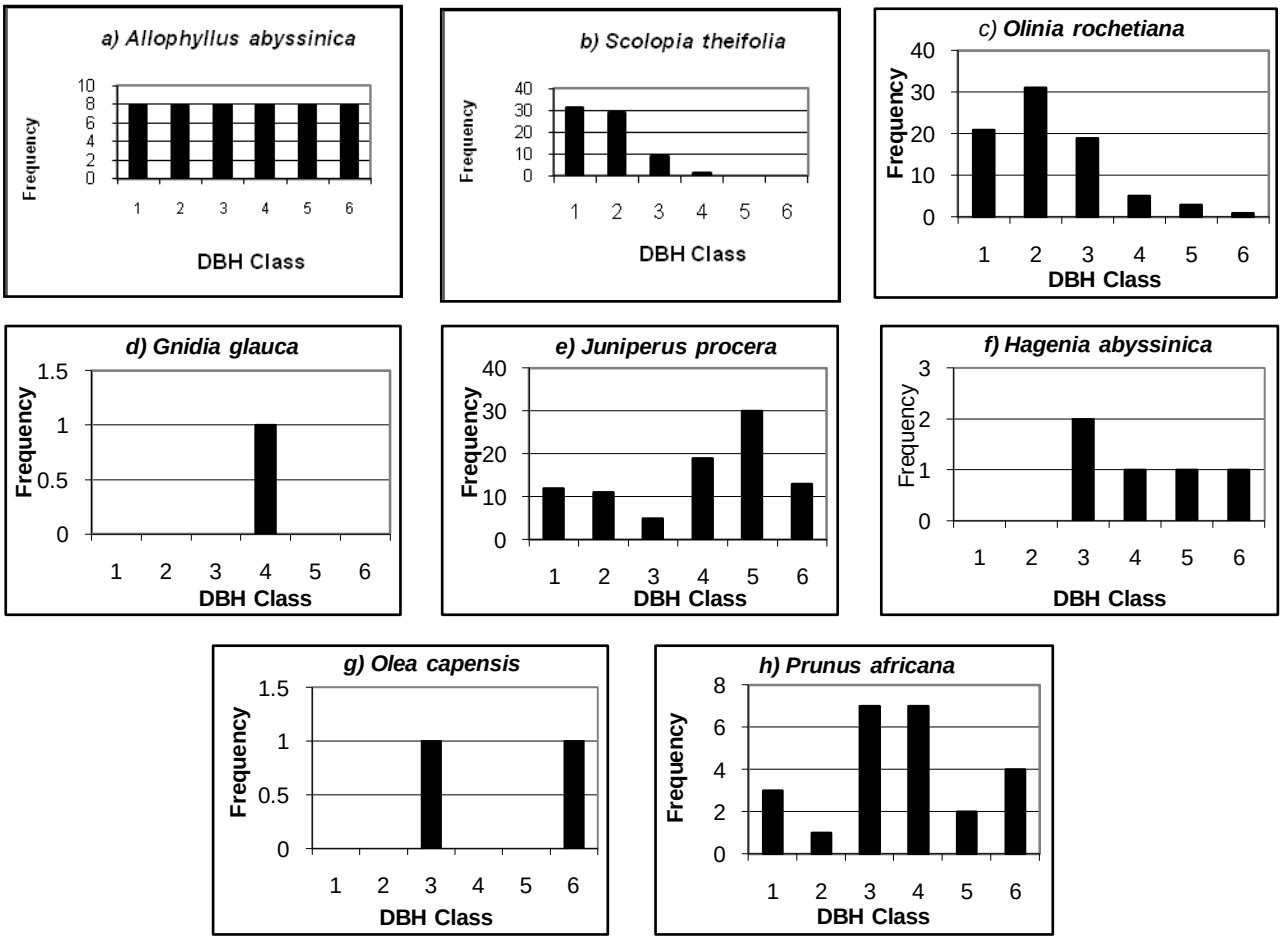


Figure 5 (a-h). Four representative patterns of woody species over the DBH classes in Chilimo Forests.

Olea europaea and *Olinia rochetiana* form the third pattern (Fig. 5c). In this pattern the number of individuals is lower in the first class and increases in the second followed by gradual decrease towards the higher classes. The fourth pattern (Fig. 5d) is a pattern with only few individuals represented in certain classes. *Maytenus addat* and *Gnidia glauca* belong to this pattern in this forest. On top of other factors, such pattern may suggest the rarity of a species in the forest as well. The fifth pattern is a pattern exhibited by *Juniperus procera* (Fig. 5e). This pattern shows that selective cutting of Juniper has been taking place on DBH classes 3 and 6 in the forest. It is important to note here that the structure of a given species could vary from forest to forest depending on the status and the history of that forest. Perhaps, this shows that there has been a special preference of different size individuals of a species for different purposes by the people living in and around the forests.

Regeneration Status of Some Woody Species

The Chilimo Forest was also investigated for the regeneration status of some selected woody species. Some species are represented by their seedlings while others by their saplings. The highest seedling was recorded for *Maytenus gracilipes* followed by *Allophylus abyssinicus* and *Bersama abyssinica* (see Table 4). The highest sapling was recorded for *Maytenus gracilipes* followed by *Podocarpus falcatus* and *Scolopia theifolia*. The highest tree/shrub number was that of *Podocarpus falcatus* denoting that this species is in a better condition in Chilimo Forest. Based on the data gathered from the field seedlings, saplings and tree/shrub distribution of some selected species are presented in Figure 6.

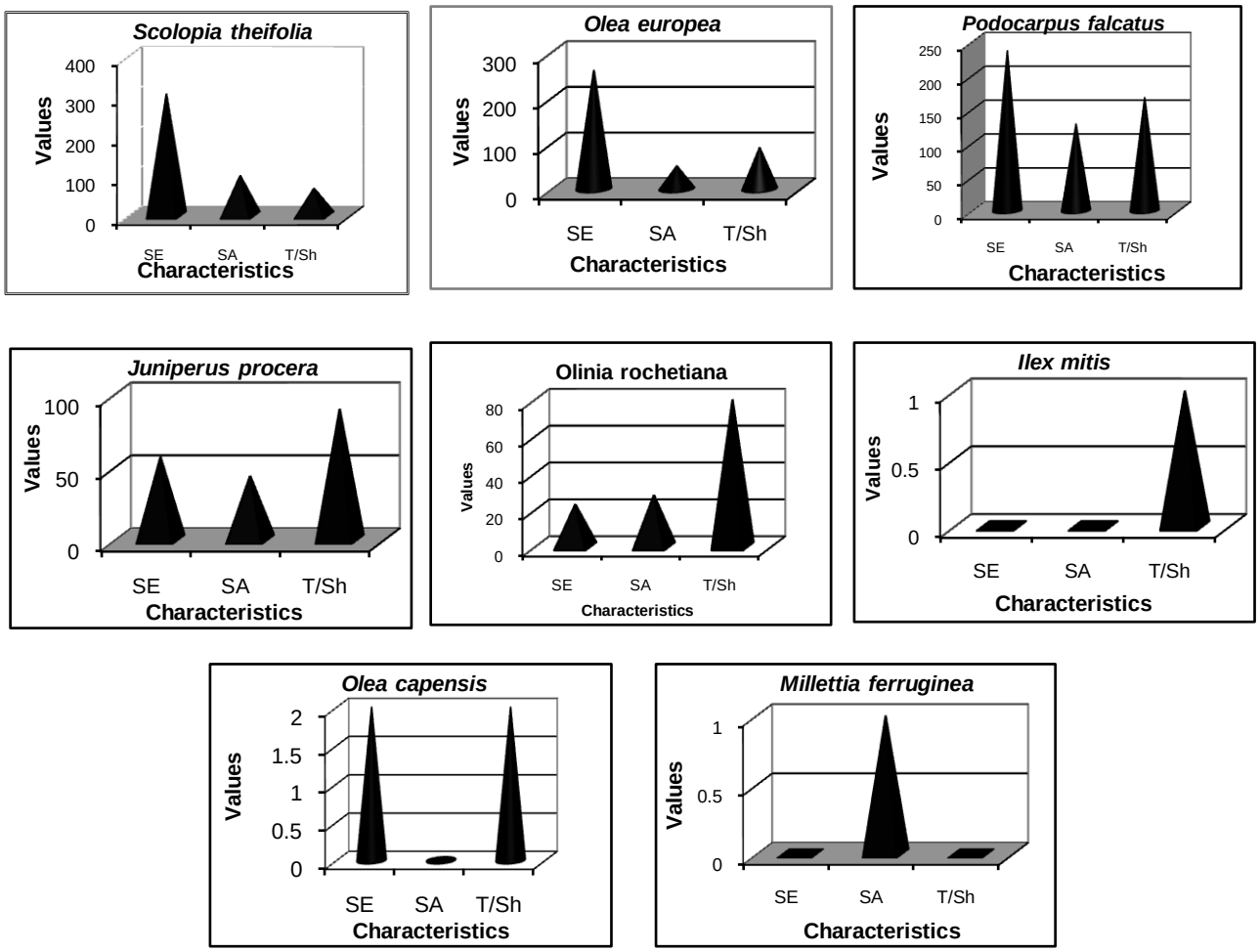


Figure 6: Seedlings, saplings and tree/shrub distribution of some selected species occurring in Chilimo Forest.

Use Values of Some Selected Species

An interview on the uses of some major plant species was made so as to deduce the extent of pressure on a particular species. The participants have pointed out the major uses of wood products and non-wood products extracted from the forest. The use of plants by the local people can be grouped into a number of non-restrictive categories. For the purposes of simplicity, the following use categories of the plants were considered here: timber, construction, farm implements, firewood, charcoal, spices, medicinal, bee forage and for hive hanging purposes. Thirty-eight species were included in the interview. Of these 13 were identified as timber species, 14 for construction, another 14 for farm implements, 35 species for firewood, 21 species for charcoal production, 13 species for medicinal purposes, 25 species for bee forage and 25 species as used for hive hanging (Figure 7). In Chilimo a given species could serve different purposes. For example, *Olea europaea* and *Prunus africana* serve 6 different purposes (Table 4).

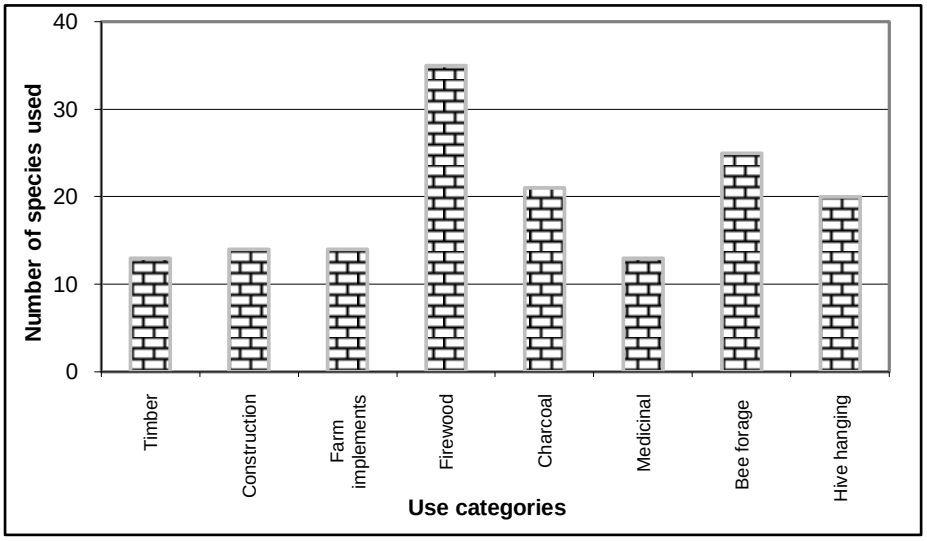


Figure 7: Use categories and number of species used in Chilimo Forest.

On top of the aforementioned uses in Chilimo Forest, there is a seed collection practice in the area. Seeds are collected from different species and sold as a means to generate income for the local people. The seed of some species are quite expensive. For example, 1 kg of the seed of *Juniperus procera* costs 50 Birr (see Table 2). In fact these extractions of seeds promote the multiplication of these species and are considered as a trend to be promoted in other places. However, care must be taken not to over-exploit the concerned species and reduce their genetic variety.

Table 2: Current cost of the seeds of some species in Chilimo as indicated by farmers.

No	Seeds of species (in kg)	Cost in Birr*
1	*Juniperus procera*	50
2	*Prunus africana*	7
3	*Podocarpus falcatus*	20
4	*Ekebergia capensis*	10
5	*Allophylus abyssinicus*	7
6	*Olea capensis*	7
7	*Apodytes dimidiata*	7
8	*Dombeya torrida*	12
9	*Hagenia abyssinica*	12
10	*Erythrina brucei*	10

Endemism

There are a number of flowering plant species in Chilimo forest that are endemic. Information on the endemic flowering plant species of Ethiopia and the levels of threat to them has been published in Ensermu et al. (1992), and Vivero et al. (in press). Based on the published Flora volumes and the lists of species in this forest, the endemic species and the levels of threat on each taxon are given in Table 3 below.

Table 3 shows that 17 endemic species have been recorded from Chilimo Forest. Based on the IUCN Criteria of level of threat, 1 species is endangered (EN) and 2 species have been evaluated as vulnerable (VU), 4 other species have been categorised as not threatened (NT). The remaining ten species have been found to be categorized as species of least concern (LC).

Table 3: Endemic species occurring in Chilimo Forest.

No	Scientific name	Status	Family
1	*Acanthus sennii*	NT	Acanthaceae
2	*Conyza nana*	EN	Asteraceae
3	*Crotalaria rosenii*	NT	Fabaceae
4	*Impatiens rothii*	LC	Balsaminaceae
5	*Kalanchoe petitiana*	LC	Crassulaceae
6	*Lippia adoensis*	LC	Verbanaceae
7	*Maytenus addat*	NT	Celastraceae
8	*Mikaniopsis clematoides*	LC	Asteraceae
9	*Phragmenthera macrosolen*	LC	Loranthaceae
10	*Polystachya rivae*	VU	Orchidaceae
11	*Rhus glutinosa subsp. glutinosa*	VU	Anacardiaceae
12	*Rhus glutinosa subsp. neoglutinosa*	LC	Anacardiaceae
13	*Satureja paradoxa*	NT	Lamiaceae
14	*Solanecio gigas*	LC	Asteraceae
15	*Thymus schimperi*	LC	Lamiaceae
16	*Vernonia leopoldi*	LC	Asteraceae
17	*Vernonia rueppellii*	LC	Asteraceae

Status of Some Selected Species

Some woody species of the Chilimo Forest are used for many purposes. Moreover, these species are not represented (if represented by few individual) by the various stages of development. It is then quite clear that such species that have been over utilized and lack replacement would eventually disappear from the forest. For example, *Gnidia glauca*, *Ilex mitis* and *Maytenus addat* (see Table 4) are not represented by either seedling or sapling stages, showing that these species are those that need immediate conservation measures. Contrary to this fact, some species though over utilized are represented by better individuals (e.g., *Podocarpus falcatus and Scolopia theifolia*) at different stages. Species that are used for various purposes and yet bearing pattern II type of population structure are those that have good reproduction and recruitment (e.g. *Scolopia theifolia*). Such species are those that don't need urgent conservation attention.

Table 4: Status of some selected species of the Chilimo Forest. Note that the structure of these species is the one discussed under population structure previously.

Species	Seedlings	Saplings	Tree/ Shrub	Structural pattern	No. of uses
Allophylus abyssinicus	404	21	40	Pattern I	4
Apodytes dimidiata	9	1	5	IV	4
Bersama abyssinica	365	33	20	III	2
Calpurnea aurea	8	5	6	IV	3
Ekebergia capensis	22		18	II	1
Galiniera saxifraga	22		6	III	2
Gnidia glauca			1	IV	4
Hagenia abyssinica	43		5	IV	4
Ilex mitis			1	IV	2
Juniperus procera	57	44	90	V	4
Maytenus addat			2	IV	2
Maytenus gracilipes	907	162	72	II	2
Myrica salicifolia	2		3	IV	4
Nuxia congesta	14	11	20	III	3
Olea capensis	2		2	IV	5
Olea europaea	259	50	90	III	6
Olinia rochetiana	23	28	80	III	5
Podocarpus falcatus	236	128	167	II	5
Prunus africana	28	1	25	III	6
Scolopia theifolia	306	107	69	II	3
Sideroxylon oxyacanthum			10	II	5

CONCLUSIONS

Chilimo Forest is one of the remaining Afromontane forests harbouring many endemic species. This forest is ecologically, socially, economically and culturally very important for the inhabitants residing near by who are mostly dependent on forest product to make their living. Loss of such a forest and the various threatened species would have great implications for the environment, biodiversity and socio-economic setup of the communities. This forest harbours species that economically and ecologically important. Yet some of these species had population structures that showed patterns with no or few individuals at lower size classes. Such species requires urgent conservation measures that will enhance healthy regeneration and guarantee sustainable uses of these species. Some other economically important species of this forest were not represented in the seedling or sapling stages denoting that they are under threat. It is therefore mandatory to implement conservation measures (both in-situ and ex-situ) for such species of the forest. Although *Juniperus procera* and *Podocarpus falcatus* are both common in Chilimo Forest, the former has been more affected than the later being extracted for timber. However, the condition seems improving, at least in forest patches situated away from the urban centre. It has been observed that the second most important timber tree species, *Podocarpus falcatus* is regenerating at an alarming rate, while *Juniperus procera* also shows encouraging recovery.

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REFERENCES

Adugna Feyissa., Teshome Soromessa and Mekuria Argaw (2013). Forest Carbon Stocks and Variations along Altitudinal Gradients in Egdu Forest: Implications of Managing Forests for Climate Change Mitigation. *Science, Technology and Arts Research Journal* 2(4):40-46.

Chaffey, D.R. (1979). Southwest Ethiopia Forest Inventory Project, A Reconnaissance Inventory of Forest in Southwest Ethiopia. Land Resources Development Centre, Tolworth Tower Surbition Survey, England.

Coetzee, J.A. (1978). Phytogeogarphical aspects of the montane forests of the chain of mountains on the eastern side of Africa. *Erdwiss Forsch* 11: 482-494.

Daniel Gamachu. (1977). Aspects of Climate and Water Budget in Ethiopia. Addis Ababa University Press, Addis Ababa.

Demel Tekatay. (2000). Vegetation Types and Forest Fire Management in Ethiopia. In: MOA and GTZ (eds.) *Proceedings of the Round Table Conference on Integerated Forest Fire Management in Ethiopia*. Ministry of Agriculture (MOA) and Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), Addis Ababa. Pp. 1-35.

EFAP. (1994). Ethiopian Forestry Action Program (EFAP). EFAP, Addis Ababa.

EMA. (1988). National atlas of Ethiopia. Ethiopian Mapping Authority, Addis Ababa.

Ensermu Kelbessa., Sebsebe Demissew., Zerihun Woldu and Edwards, S. (1992). Some threatened endemic plants of Ethiopia. In: Botany 2000 (Edwards, S. and Zemede Asfaw, eds.): East and Central Africa. NAPERICA Monograph Series No. 2: 35-55.

Ensermu Kelbessa and Teshome Soromessa. (2008). Interfaces of Regeneration, Structure, Diversity and Uses of Some woody Species in Bonga Forest, a Unique Gene Reserve for Wild Coffee. *SINET: Ethiopian Journal of Science* 31(2): 121-134.

Friis, I. (1986). The forest Vegetation of Ethiopia. *Acta Universitatis Upsaliensis Symbolae Botanicae Upsalienses* XXVI: 31-47.

Friis, I. (1992). Forest and Forest Trees of Northeast Tropical Africa. *Kew Bulletin Additional Series* 15: 1-396.

Friis, I. and Mesfin Tadesse (1990). The evergreen forests of tropical Northeast Africa. *Mitteilungen aus dem Institut fuer Allgemeine Botanik Hamburg* 23a: 249-263.

Friis, I., Rasmussen, F.N. and Vollesen, K. (1982). Studies in the flora and vegetation of Southwest Ethiopia. *Opera Botanica* 63: 8-70.

Gilbert, E.F. (1970). Mount Wachacha: A botanical Commentary. *Walia* 2: 3-12.

Hailu Sharew. (1982). An Ecological Study of a Forest in Jemjem in Sidamo. MSc Thesis, Addis Ababa University, Addis Ababa. Unpublished.

Haugen, T. (1992). Woody vegetation of Borana, South Ethiopia, a study on the main vegetation types of the area. SINET: *Ethiopian Journal of Science* 15: 117-130.

Hedberg, I. and Edwards, S. (eds.) (1989). Flora of Ethiopia, Vol 3. Pittosporaceae to Araliaceae. The National Herbarium, Addis Ababa University, Ethiopia and Department of systematic Botany, Uppsala University, Sweden.

Hedberg, O. (1951). Vegetation belts of the East African Mountains. *Svensk Botanisk Tidskrift* 45:140-204.

Hedberg, O. (1957). Afroalpine vascular plants, a taxonomic revision. *Symbolae Botanicae Upsaliensis* 15(1): 1-411.

Kakudidi, E.K., Bukenya-Ziraba, R. and J.M. Kasenene. (2000). The medicinal plants in and around Kibale National Parks in western Uganda. *Lidia* 5: 109-124.

Kamatenesi-Mugisha, M., Hoft, R. and R. Bukenya-Ziraba. (2000). Ethnobotanical use of *Rytgynia* (nyakibazi) in Bwindi Impenetrable National Park, SW Uganda. *Lidia* 5: 97-108.

Lamprecht, H. (1989). Silviculture in Tropics. Tropical Forest Ecosystems and their tree species-possibilities and methods for their long term utilization. TZ-Verlagsgesellschaft GmbH, Rossdort, Germany.

Logan, W.E.M. (1946). An introduction to the forests of central and southern Ethiopia. *Imperial Forestry Institute Paper* 24: 1-58.

Maundu, P.M. (1995). Methodology of collecting and sharing indigenous knowledge: Case study. *Indigenous Knowledge and Development Monitor* 3: 3-5.

Miehe, G. and Miehe, S. (1994). Ericaceous Forests and Heath lands in the Bale Mountains of South Ethiopia: Ecology and man's Impact. Stiftung Walderhaltung in Africa, Hamburg.

Mesfin Abebe. (1998). *Nature and Management of Ethiopian Soils*. Alemaya University of Agriculture. Ethiopia. Pp 272.

Mesfin Tadesse. (1992). A survey of the evergreen forests of Ethiopia. *NAPRECA Monograph Series* 2: 1-18.

Mohr, P.A. (1971). The Geology of Ethiopia. University College of Addis Ababa, Central Printing Press, Addis Ababa. Pp 268.

Mooney, H.F. (1963). An account of two journeys to the Araenna Mountains in Bale province (Southeast Ethiopia), 1958 and 1959-1960. *Proceedings of the Linnean Society* 172: 127-147.

Murphy, H.P. (1958). The Fertility Status of some Soils of Ethiopia. Jimma University. Jimma, Ethiopia, Pp 456.

Pichi-Sermolli, R.E.G. (1957). Una carta geobotanica dell' Africa Orientale (Eritrea, Etiopia, Somalia). *Webbia* 13: 15-132.

Sebsebe Demissew. (1988). The Floristic composition of the Menagesha State Forest and the Need to Conserve Such Forest in Ethiopia. *Mountain Research and Development* 8: 243-247.

Tamrat Bekele (1994). Vegetation ecology of remnant Afromontane forests on the Central Plateau of Shewa, Ethiopia. *Acta phytogeographica suecica* 79(Uppsala):61.

Teshome Soromessa, Demel Teketay, Sebsebe Demissew (2004). Ecological study of the vegetation in Gamo Gofa zone, southern Ethiopia. *Tropical Ecology* 45(2): 209-221.

Teshome Soromessa and Ensermu Kelbessa (2013a). Diversity and Endemicity of Chilimo Forest, Central Ethiopia. *Biosceience Discovery* 4(1): 1-4.

Teshome Soromessa and Ensermu Kelbessa (2013b). Diversity, Ecology and Regeneration Studies of Bonga, Borana and Chilimo Forests of Ethiopia. Lambert Academic Publishing, Saarbrücken, Germany, Pp 140, ISBN 978-3-659-41509-8.

Teshome Soromessa (2013). Ecological Phytogeography: A Case Study of *Commiphora* Species. *Science, Technology and Arts Research Journal* 2(3): 93-104.

Tewolde Berhan Gebre Egziabher. (1986). Ethiopian vegetation – past, present and future. *SINET: Ethiopian Journal of Science* 9: 1-13.

Tewolde Berhan Gebre Egziabher. (1988). Vegetation and environment of the mountains of Ethiopia: implications for utilisation and conservation. *Mountain Research and Development* 8: 211-216.

Tewolde Berhan., Gebre Egziabher. (1991). Diversity of Ethiopian flora. In: Engles, J.M.M., Hawkes, J.G. and Melaku Worede (eds.). Plant Genetic Resources of Ethiopia, Cambridge University Press, Cambridge. Pp: 75-81.

Uhlig, S.K. (1988). Mountain forests and upper tree limit on the southeastern platueau of Ethiopia. *Mountain Research and Development* 8: 227-234.

Uhlig, S.K. and Uhlig, K. (1990). The floristic composition of a natural montane forest in southeastern Ethiopia. *Feddes Repertorium* 101: 227-234.

Vivero, J.L., Ensermu Kelbessa and Sebsebe Demissew. (in prees). The red list of endemic flowering plants of Ethiopia and Eritrea, 596 taxa.

von Breitenbach, G. (1961). Forests and woodlands of Ethiopia, a geobotanical contribution to the knowledge of the principal plant communities of Ethiopia, with special regards to forestry. *Ethiopian Forest Review* 1: 5-16.

von Breitenbach, G. (1963). Indigenous Trees of Ethiopia. Ethiopian Forestry Association, Addis Ababa. Pp 276.

Westphal, E. (1975). Agricultural Systems in Ethiopia. Centre for Agricultural Publishing and Documentation, Wageningen.

White, F. (1983). The vegetation of Africa. A Descriptive Memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa. *Natural Resources Research* 20: 1-356.

Woldemichael Kelecha. (1979). Compiled Reports on Ethiopian Forest, Original by Russ, G. W. (1945).

Zerihun Woldu. (1985). *Variation in Grassland Vegetation on the Central Plateau of Shewa, Ethiopia, in Relation to Edaphic factors and Grazing Conditions*. Doctorla Thesis, Uppsala University, Uppsala.

Zerihun Woldu and Backeus, I. (1991). The Shrubland Vegetation in Western Shewa, Ethiopia and its Possible Recovery. *Journal of Vegetation Science* 2: 173-180.

Zerihun Woldu., Feoli, E. and Lisanework Nigatu. (1989). Partitioning an elevation gradient of vegetation from southeastern Ethiopia by probability methods. *Vegetation* 18:189-198.